



# Sector Specific Technology Transfer Guide

## *Plastic and Rubber Products Industry*

(SIC Groups 306, Fabricated Rubber Products, and 308, Miscellaneous Plastics Products)



Indiana Department of Environmental Management  
Office of Pollution Prevention & Technical Assistance  
800-988-7901  
[www.in.gov/idem/oppta/](http://www.in.gov/idem/oppta/)

Indiana Clean Manufacturing Technology & Safe Materials Institute  
Purdue University  
765-463-4749  
[www.ecn.purdue.edu/CMTI/](http://www.ecn.purdue.edu/CMTI/)

This guide was developed to provide an overview of pollution prevention practices and technologies available to the plastic products industry. The pollution prevention strategies identified in this guide focus primarily on the reduction of air emissions. The guide has been organized by production processes and the pollution prevention strategies, and categorized by the initial costs of those technologies. Each technology is ranked according to the potential reductions in air emissions resulting from the implementation of those technologies (☼ = a low potential for significant emission reductions, ☼☼☼☼ = the highest potential for significant emission reductions).

### **Gluings and Adhesive Bonding Operations**

#### ***Low Cost Pollution Prevention Technologies:***

- **Polyurethane hot melt glues (☼☼☼☼)** – Replace solvent-borne structural and edgebanding glues with polyurethane hot melt glues.
- **Polyvinyl acetate (PVA) glues (☼☼☼☼)** – Replace solvent-borne glues with an aqueous-based PVA glue.
- **Waterborne adhesives (low to no-formaldehyde formulations) (☼☼☼☼)** - Replace solvent-borne adhesives with aqueous-based adhesives.
- **Operator training (☼☼☼)** – Conducting hands-on training sessions in proper spray techniques for employees applying atomized adhesives using manual application processes.
- **Flush with dirty solvent first, then fresh solvent (☼☼☼)** – Pre-cleaning application equipment with “dirty” solvent first can reduce solvent emissions and usage significantly.
- **Keep all containers closed** (this includes all containers used to store adhesives, solvents, additives, and liquid waste materials) (☼☼) – To reduce air emissions and preserve the chemical properties of the adhesives and glues, instruct all employees to keep containers used to store these materials closed when not in use.
- **Inspect storage, transfer, and application equipment (☼☼)** – On a regular basis, inspect storage container, transfer equipment, and application equipment used to store, transfer or apply solvent-borne adhesives and solvents for leaks or malfunctions.

#### ***Medium Cost Pollution Prevention Technologies:***

- **Soy-based Adhesives (☼☼☼☼)** – Replace adhesives based on toxic chemicals with soy adhesives.

- **High volume low pressure (HVLP) application equipment (☼☼)** – Replacing conventional atomized spray equipment with HVLP spray equipment.
- **Enclosed spray gun wash systems (☼)** – Use an enclosed gun wash system to clean conventional and HVLP spray application equipment.

#### ***High Cost Pollution Prevention Technologies:***

- **Roll coat application (☼☼☼)** – Replace atomize application equipment with a roll coat application system.
- **Mechanical assembly (☼☼☼)** – Solvent and adhesive bonding can be replaced with mechanical means of assembly, such as screws or built-in snaps.
- **Thermal welding (☼☼☼)** – Solvent and adhesive bonding can be replaced with thermal welding, which involves melting the bond line, between two parts having similar melt temperatures, to form a weld. There are several types of thermal welding technologies, including electromagnetic (induction) welding, ultrasonic welding, radio frequency (RF) welding, vibration welding, and spin welding.

### **Fiber Reinforced Plastic (FRP) Part Production**

#### ***Low Cost Pollution Prevention Technologies:***

- **Controlled Spray Program (☼☼☼)** – Covering elements such as training, equipment adjustment, and flanges (FRP-specific), a fully implemented program can reduce material usage and emissions by up to 30%.
- **Reduce the time it takes to reach steady-state operating conditions (☼☼☼)** – Implementing procedures and continuously tweaking them can greatly reduce the amount of waste oftentimes generated at process startup.
- **Operator training (☼☼)** – Conducting hands-on training sessions in proper spray techniques for employees applying atomized coatings using manual application processes.
- **Flush with dirty solvent first, then fresh solvent (☼☼)** – Pre-cleaning spray application equipment with “dirty” solvent first can reduce solvent emissions and usage significantly.
- **Implement good inventory management methods (☼☼)** – Waste can be reduced by rotating stock, paying attention to shelf life, refusing vendor samples that would later be discarded, and minimizing container waste.
- **Keep all containers closed** (this includes all containers used to store resins, solvents, additives, and liquid waste materials) (☼) – To reduce air emissions and preserve the chemical properties of the resins and solvents, instruct all employees to keep containers used to store these materials closed when not in use.
- **Inspect storage, transfer, and application equipment (☼)** – On a regular basis, inspect storage container, transfer equipment, and application equipment used to store, transfer or apply resins and solvents for leaks or malfunctions.
- **Pre-inspect molds (☼)** – Catching obvious defects before you begin can eliminate the material and labor that would be wasted if caught after many parts have been produced.

#### ***Medium Cost Pollution Prevention Technologies:***

- **Utilize automatic dispensing and weighing equipment (☼☼☼)** – Minimizes waste due to spills from manual dispensing, prevents excessive material usage, and provides additional quality control as a bonus.
- **Low HAP content resins and gel coats (☼☼☼)** – Replace high HAP content resins and gel coats with low HAP resins and gel coats.

#### ***High Cost Pollution Prevention Technologies:***

- **Closed-molding (☼☼☼)** - Spray application of fiber-reinforced plastics can be replaced by closed-molding techniques, such as resin transfer molding, and reduce material usage and emissions by up to 80%.
- **Non-atomized resin & gel coat spray equipment (☼☼☼)** – Can replace atomized spray equipment, such as HVLP and air-assisted airless, and reduce material usage and emissions by up to 30%.

### **Injection Molding/Extrusion Operations**

#### ***Low Cost Pollution Prevention Technologies:***

- **Mold lubricants (☼☼☼)** – Can be selected to be removed without the use of toxic/hazardous mold cleaners.
- **Reduce the time it takes to reach steady-state operating conditions (☼☼☼)** – Implementing procedures and continuously tweaking them can greatly reduce the amount of waste oftentimes generated at process startup.
- **Non-toxic/hazardous mold cleaners (☼☼)** – Replace toxic/hazardous mold cleaners with non-toxic/hazardous alternatives.
- **Implement good inventory management methods (☼☼)** – Waste can be reduced by rotating stock, paying attention to shelf life, refusing vendor samples that would later be discarded, and minimizing container waste.
- **Keep all containers closed** (this includes all containers used to store solvents, additives, and liquid waste materials) (☼) – To reduce air emissions instruct all employees to keep containers used to store these materials closed when not in use.
- **Inspect process equipment (☼)** – On a regular basis, inspect process equipment for malfunctions.
- **Pre-inspect molds (☼)** – Catching obvious defects before you begin can eliminate the material and labor that would be wasted if caught after many parts have been produced.
- **Low HAP mold release (☼)** – Replace mold releases that are high in HAP content with low HAP containing alternative mold release.

### **Surface Coating Operations**

#### ***Low Cost Pollution Prevention Technologies:***

- **Operator training (☼☼)** – Conducting hands-on training sessions in proper spray techniques for employees applying atomized coatings using manual application processes.
- **Keep all containers closed** (this includes all containers used to store coatings, solvents, additives, and liquid waste materials) (☼) – To reduce air emissions and preserve the chemical

properties of the coatings and solvents, instruct all employees to keep containers used to store these materials closed when not in use.

- **Inspect coating storage, transfer, and application equipment (☼)** – On a regular basis, inspect storage container, transfer equipment, and application equipment used to store, transfer or apply solvent-borne coatings and solvents for leaks or malfunctions.
- **Monitoring of coatings defects (☼)** – Track the number of coatings defects, the type of defects detected, and the spraybooth or production line generating the defects. Use this information to determine the source of the defects and take corrective actions to reduce or eliminate future coating defects.

#### ***Medium Cost Pollution Prevention Technologies:***

- **Waterborne coatings (☼☼☼)** – Replace solvent-borne coatings with low-to-no VOC/HAP waterborne coatings.
- **High solids paints and topcoats (☼☼☼)** - Replace low solids solvent-borne coatings with low VOC/HAP high solids coatings.
- **High volume low pressure (HVLP) application equipment (☼☼☼)** – Replace conventional atomized spray equipment with HVLP spray equipment.
- **Enclosed spray gun wash systems (☼)** – Use an enclosed gun wash system to clean conventional and HVLP spray application equipment.
- **Hard pipe system (☼)** - Transfer VOC/HAP containing materials by means of a hard pipe system.

#### ***High Cost Pollution Prevention Technologies:***

- **Electrostatic application equipment (☼☼☼☼)** – Replace conventional spray equipment with electrostatic application equipment.
- **UV curable coatings (☼☼☼☼)** – Replace solvent-borne coatings with UV curable coatings.
- **Vacuum coating (☼☼☼☼)** - Replace atomized coating systems with a vacuum coating system using waterborne coatings.
- **Air-assisted airless application equipment (☼☼☼)** – Replace conventional spray equipment with air-assisted airless application equipment.

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### **Links to Additional Information**

#### ***Gluing & Adhesive Bonding Operations:***

##### **Glues and Adhesives (General)**

- CMTI Case-Study: [www.ecn.purdue.edu/CMTI/Technology\\_Transfer/holiday-rambler](http://www.ecn.purdue.edu/CMTI/Technology_Transfer/holiday-rambler)
- CMTI Case-Study: [www.ecn.purdue.edu/CMTI/Technology\\_Transfer/FleetP2.doc](http://www.ecn.purdue.edu/CMTI/Technology_Transfer/FleetP2.doc)

#### ***Fiber Reinforced Plastic Part Production:***

##### **Non-Atomized Gel-Coat Application**

- CMTI Case-Study: [www.ecn.purdue.edu/CMTI/Technology\\_Transfer/AltecP2](http://www.ecn.purdue.edu/CMTI/Technology_Transfer/AltecP2)

#### ***Injection Molding/Extrusion Operations:***

- North Carolina Division of Pollution Prevention and Environmental Assistance Fact Sheets: Fiber Reinforced Plastic (FRP) -- Pollution Prevention Opportunities [www.p2pays.org/ref/12/11698.pdf](http://www.p2pays.org/ref/12/11698.pdf) ; Fiberglass Manufacturer Substitutes Acetone With a Water-Based Emulsifier [www.p2pays.org/ref/03/02100.pdf](http://www.p2pays.org/ref/03/02100.pdf)

### ***Surface Coating Operations:***

#### High Solids Coatings

- CMTI Case-Study: [www.ecn.purdue.edu/CMTI/Technology\\_Transfer/innvtech](http://www.ecn.purdue.edu/CMTI/Technology_Transfer/innvtech)

#### Electrostatic Coatings Application

- CMTI Case-Study: [www.ecn.purdue.edu/CMTI/Technology\\_Transfer/UTAP3](http://www.ecn.purdue.edu/CMTI/Technology_Transfer/UTAP3)

#### Operator Training

- CMTI Case-Study: [www.ecn.purdue.edu/CMTI/Technology\\_Transfer/NESHAPP3](http://www.ecn.purdue.edu/CMTI/Technology_Transfer/NESHAPP3)

#### Coatings (General)

- CMTI Case-Study: [www.ecn.purdue.edu/CMTI/Technology\\_Transfer/NORINDP2](http://www.ecn.purdue.edu/CMTI/Technology_Transfer/NORINDP2)
- Paint and Coatings Resource Center [www.paintcenter.org/](http://www.paintcenter.org/)
- Coatings Guide™: [cage.rti.org/](http://cage.rti.org/)

### ***Additional Sites:***

- Pollution Prevention Resource Exchange: [www.p2rx.org/](http://www.p2rx.org/)
- Indiana Clean Manufacturing Technology & Safe Materials Institute: [www.ecn.purdue.edu/CMTI/](http://www.ecn.purdue.edu/CMTI/)
- IDEM's Office of Pollution Prevention & Technical Assistance: [www.in.gov/idem/oppta/](http://www.in.gov/idem/oppta/)

## Summary Table

	Good Pollution Reduction Opportunities		→	Best Pollution Reduction Opportunities	
<div>Lowest Cost</div> <div>↓</div>	<ul style="list-style-type: none"><li>Keep containers closed (<i>G,F,M,SC</i>)</li><li>Inspect equipment (<i>G,F,M,SC</i>)</li><li>Pre-inspect molds for obvious defects before startup (<i>F,M</i>)</li><li>Low HAP mold release (<i>M</i>)</li><li>Monitor coating defects (<i>SC</i>)</li></ul>	<ul style="list-style-type: none"><li>Operator training (<i>G,F,SC</i>)</li><li>Flush with dirty solvent first (<i>G,F</i>)</li><li>Implement good inventory management methods (<i>F,M</i>)</li><li>Reduce the time it takes to reach steady-state operating conditions (<i>F,M</i>)</li><li>Replace toxic/hazardous mold cleaners with non-toxic/non-hazardous alternatives (<i>M</i>)</li></ul>		<ul style="list-style-type: none"><li>Polyurethane hot melt glues (<i>G</i>)</li><li>Polyvinyl acetate (PVA) glues (<i>G</i>)</li><li>Waterborne adhesives (<i>G</i>)</li><li>Controlled Spray Program (<i>F</i>)</li><li>Select mold lubricants that can be removed without using toxic/ hazardous mold cleaners (<i>M</i>)</li></ul>	
	<ul style="list-style-type: none"><li>Enclosed spray gun wash system (<i>G, SC</i>)</li><li>Hard pipe transfer system (<i>SC</i>)</li></ul>	<ul style="list-style-type: none"><li>HVLP application equipment (<i>G, SC</i>)</li><li>High solids paints and topcoats (<i>SC</i>)</li></ul>		<ul style="list-style-type: none"><li>Soy-based adhesives (<i>G</i>)</li><li>Waterborne coatings (<i>SC</i>)</li><li>Utilize automatic dispensing and weighing equipment (<i>F</i>)</li><li>Low HAP resins &amp; gel coats (<i>F</i>)</li></ul>	
	<div>Highest Cost</div>		<ul style="list-style-type: none"><li>Air-assisted airless equipment (<i>SC</i>)</li></ul>		<ul style="list-style-type: none"><li>Roll coat application (<i>G</i>)</li><li>Thermal welding (<i>G</i>)</li><li>Mechanical assembly (<i>G</i>)</li><li>Closed-molding/RTM (<i>F</i>)</li><li>Non-atomized resin &amp; gel coating (<i>F</i>)</li><li>Electrostatic Application (<i>SC</i>)</li><li>Vacuum coating (<i>SC</i>)</li><li>UV curable coatings (<i>SC</i>)</li></ul>

*G* - Gluing and Adhesive Bonding Operations

*F* - FRP Operations

*M* - Molding operations

*SC* – Surface Coating Operations